Atmospheric CO2 concentration

Here in Figure 1 is the monthly atmospheric CO_2 concentration measured at the Mauna Loa Observatory, Hawaii, Latitude19.5° N, Longitude 155° W, elevation 3397m, for the 64 year period from March 1958 to September 2021.

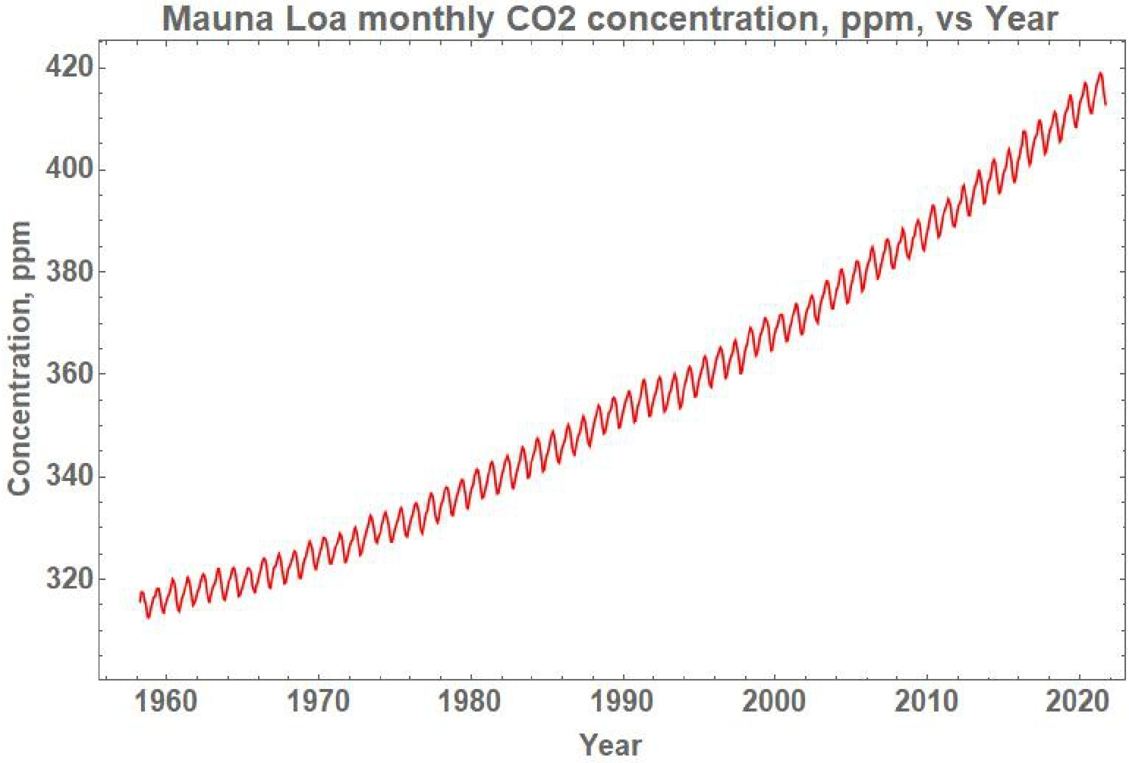

Figure 1. Monthly atmospheric CO_2 concentration, Mauna Loa Observatory, Source:[Ref. 2]

The source file, Ref. 2, lists the data in 10 columns. The columns used here were columns 3 and 4, the date in Excel and decimal format, column 9 being the measured CO_2 concentration with missing values in-filled from a smoothed fit to the data and column 10 being the seasonally adjusted measurements again with missing values in-filled.

The monthly CO_2 concentration had an average rate of increase over the 64 year period from March 1958 to September 2021 of 1.59 ppm pa. For the 5 year period March 1958 to March 1963 the rate was 0.68 ppm pa and for the 5 year period September 2016 to September 2021 the rate was 2.55 ppm pa, that is, the rate of increase has steadily accelerated over time to be almost four times greater than it was 59 years earlier. The range is from a minimum of 312.44 to a maximum of 418.95 ppm.

The amplitude of the seasonal variation was estimated to range from 5.2 ppm to 8.03 ppm, increasing in amplitude over time, in an irregular fashion. The maxima occurred, on average, in early May, which is the beginning of Summer, and the minima in late September, at the end of Summer. The greatest seasonal variation took place between September 2015 and April 2016. This means that the CO_2 concentration rose during the cool of Winter and fell during the heat of Summer, which is out of phase with the UN IPCC claim that increased CO_2 concentration causes an increase in temperature. Nor does the UN IPCC hypothesis provide an explanation for the steady increase in the rate of increase of the CO_2 concentration.

Temperature and CO_2 concentration

Here is 514 months of empirical data, showing a distinct lack of a relationship between the

Tropics satellite lower troposphere temperature [Ref.1] and the seasonally adjusted atmospheric CO_2 concentration at the Mauna Loa Observatory.

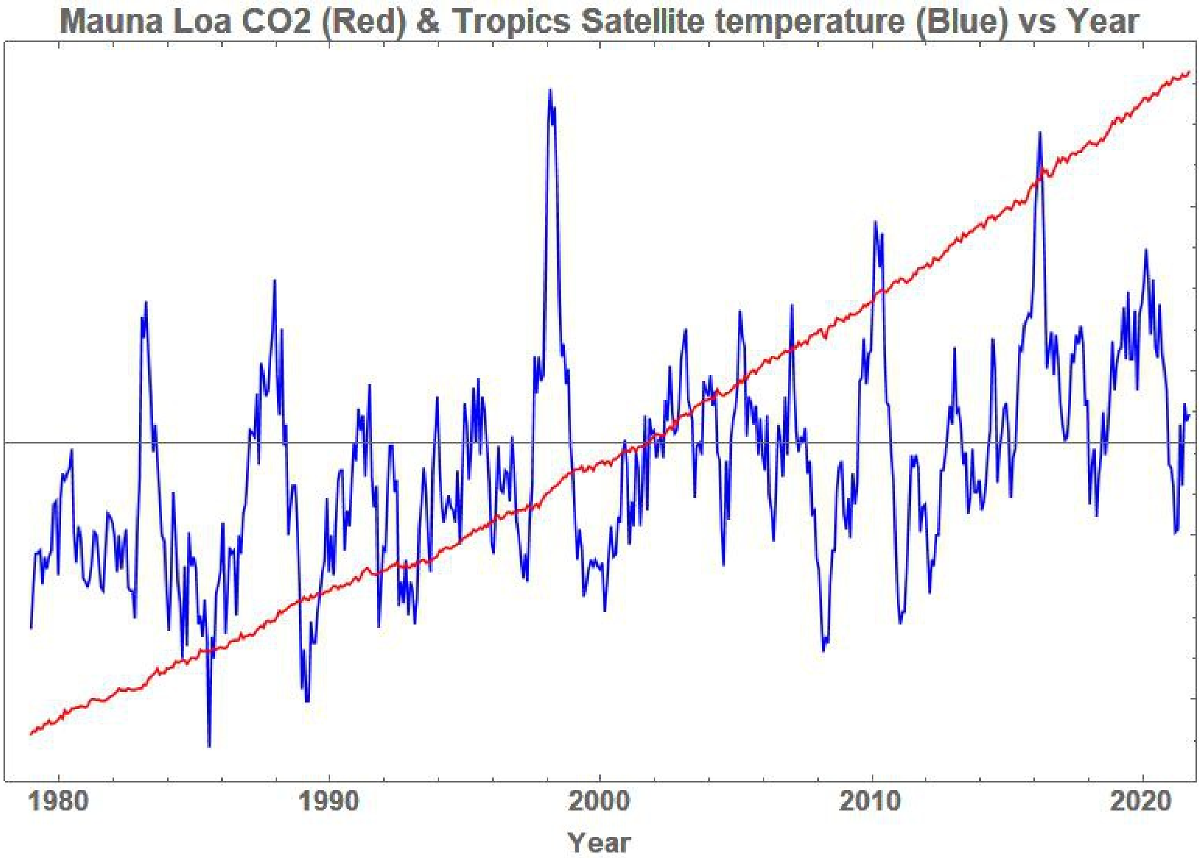

Figure 2. Mauna Loa Observatory, Source: [Ref. 1] and [Ref. 2]

Figure 2 shows the monthly satellite lower troposphere temperature for the Tropics zone, 20° South to 20° North, in blue, and the relevant monthly CO_2 concentration in red after removal of the seasonal variation so as to match the residual temperature series. The range for the monthly CO_2 concentration is from 335.78 ppm to 416.42 ppm. The range for the Tropics temperature is from -0.99° Celsius to +1.15° Celsius with respect to a 30 year average base value. The clear and obvious difference between the two raises the possibility that there may be no common causal factor whereby the CO_2 concentration drives the temperature as claimed by the UN IPCC.

Calculation of the Ordinary Linear Regression between the two time series gave a correlation coefficient of 0.471 from the 514 monthly data pairs. This is a measure of the relationship between the background linear trend of each of the time series as shown by an almost identical correlation of 0.470 between the temperature and the time. The correlation between the CO_2 concentration and the time was 0.995, that is, the se$_a$sonal adjusted CO_2 concentration time series was practically a linear trend with respect to time. Any pair of linear trends, no matter what their source, will have a high correlation coefficient of about 1.0 which is necessarily of no causal significance as a background linear trend with respect to time can be calculated for any time series.

Detrending of the pair of time series in order to assign a statistical significance to the correlation coefficient gave a value of 0.042 showing that the above correlation of 0.471 was mainly the result of the positive linear trend for each series. Statistical tests of both time series indicated that neither series was a random Normal statistical distribution. The Spearman Rank test gave a value of 0.045 with a 31% probability that the correlation could be zero.

An autocorrelation test of both detrended series confirmed that neither series was a random sequence, that is, each measured value was partly dependent, in time, on the previous value. The Durbin-Watson test of the joint time series gave a result of 0.28 which indicates positive autocorrelation. The autocorrelation was estimated to be 0.86. This mandated the application of a First Order Autoregressive Model for the analysis of the combined time series whereby the transformed series gave a correlation coefficient of 0.051 with a 27% probability that the correlation coefficient could be zero from the Spearman Rank test. Calculation of the cross correlation between the detrended pair of Tropics zone temperature and seasonally adjusted CO_2 concentration showed that the CO_2 changes lagged the temperature changes by eleven months.

Applying the above procedure using the Tropics Land component of the satellite lower troposphere temperature gave a correlation of 0.57 between the temperature and the seasonal adjusted CO_2 concentration. On detrending, the correlation was 0.049, the Durbin-Watson test was 0.44 and the autocorrelation was estimated to be 0.78. Applying the First Order Autoregressive Model gave a correlation of 0.04 with a 40% probability that the correlation could be zero from the Spearman Rank test. Calculation of the cross correlation between the detrended pair of Tropics Land temperature and seasonally adjusted CO_2 concentration showed that the CO_2 changes lagged the temperature changes by eleven months.

Applying the procedure using the Tropics Ocean component of the satellite lower troposphere temperature gave a correlation of 0.43 between the temperature and the seasonal adjusted CO_2 concentration. On detrending, the correlation was 0.04, the Durbin-Watson test was 0.27 and the autocorrelation was estimated to be 0.87. Applying the First Order Autoregressive Model gave a correlation of 0.051 with an 22% probability that the correlation could be zero from the Spearman Rank test. Calculation of the cross correlation between the detrended pair of Tropics Ocean temperature and seasonally adjusted CO_2 concentration also showed that the temperature changes preceded the CO_2 changes by eleven months.

In summary, the correlation between the satellite lower troposphere temperature and the CO_2 concentration for the Mauna Loa Observatory was of the order of 0.05 with an indeterminate probability as to whether or not the relationship is significant. Cross correlation determined that the changes in CO_2 concentration lagged the temperature change by eleven months so it could not possibly be the cause of the earlier temperature changes.

The result was supported by analysis of data from:
(1) Macquarie Island in the Southern Ocean at Latitude 54.48° South, Longitude 158.97° East, altitude 12 m,
(2) Mt Waliguan, Tibetan Plateau, China, Lat. 36.28° N, Long. 100.9° E, altitude 3810 m,
(3) Point Barrow, Alaska,
(4) South Pole Station, Antarctica, and
(5) Cape Grim, Tasmania,
as may be seen on the accompanying pages at www.climateauditor.com .

In every case, as the probabilities of a positive correlation coefficient were not statistically significant, the UN IPCC proposition that increased CO_2 caused increased temperature could not be supported and the conclusion must be that the null hypothesis applies, namely that the correlation coefficients were zero.

The above conclusion is totally at odds with the statements from the United Nations climate body, the Intergovernmental Panel on Climate Change. The Policymakers Summary from Climate Change, The IPCC Scientific Assessment, 1990, being the, then, final Report of Working Group 1

of the IPCC, opened with the statement, page XI:

"EXECUTIVE SUMMARY
We are certain of the following:

• there is a natural greenhouse effect which already keeps the Earth warmer than it would otherwise be

• emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface. The main greenhouse gas, water vapour, will increase in response to global warming and further enhance it." – end quote.

After decades of research into the relationship between the atmospheric CO_2 concentration and temperature, the latest, Fifth Assessment Report, 2015, of the IPCC, the Synthesis Report, Summary for Policymakers, page 8, made the claim:

"SPM 2.1 Key drivers of future climate
Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. ...." – end quote.

Temperature and Rate of Change of CO_2 concentration

Here is 42 years of empirical data clearly showing a positive relationship between the detrended variables, satellite temperature and the rate of change of atmospheric CO_2 concentration at the Mauna Loa Observatory.

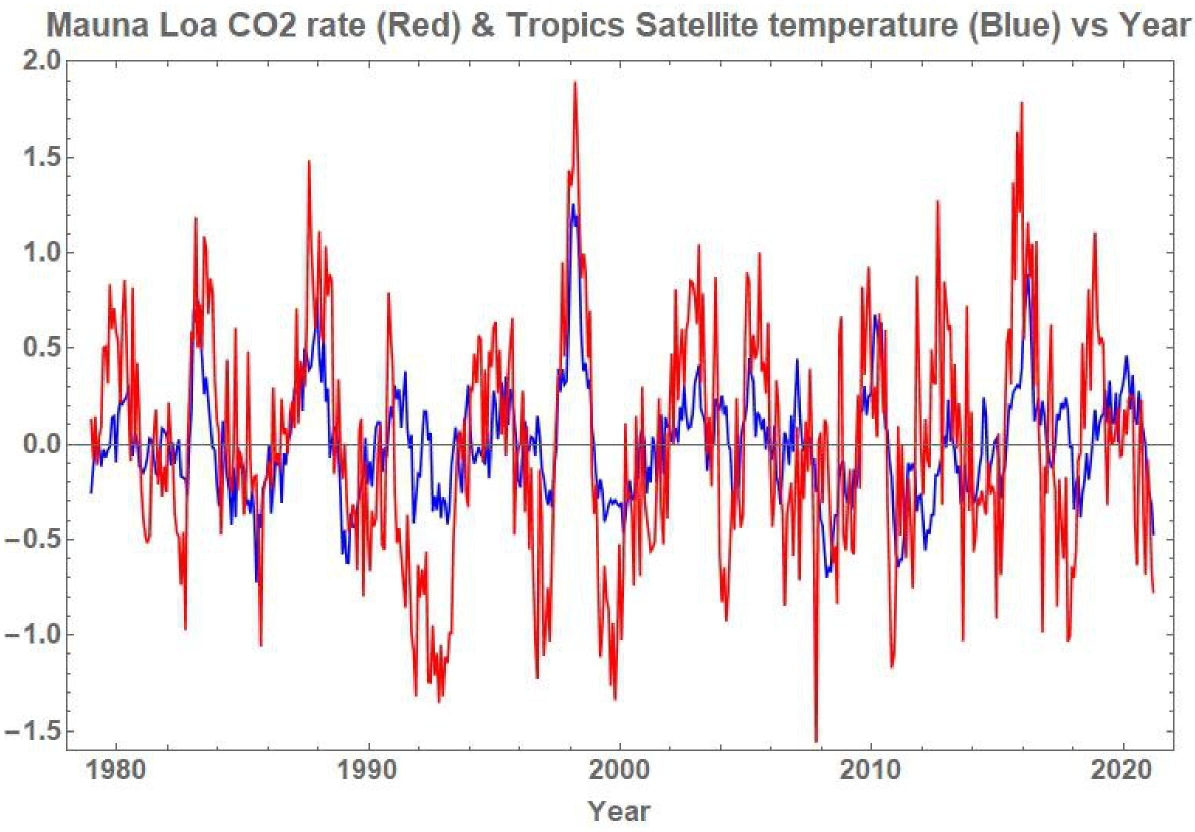

Figure 3. Mauna Loa Observatory detrended CO_2 annual increment & satellite Tropics temperature.

Figure 3 shows the monthly satellite lower troposphere temperature for the Tropics zone, in

blue, and the annual change in CO_2 concentration in red. The obvious correlation between the two raises the possibility that there may be some common causal factor whereby the temperature drives the rate of change of CO_2 concentration. It is not possible for the rate of change of CO_2 to cause the temperature level as a time rate of change does not define a base. For example a rate of 2 ppm per annum could be from 0 to 2 ppm in 12 months, 456 to 458 ppm in 12 months or any other pair of numbers that differ by 2.

Note that the satellite temperature data is supplied as a residual after adjustment for the estimated seasonal variation. This makes it directly comparable to the annual rate of change of CO_2 concentration as taking the annual rate eliminates the seasonal variation. The range, after detrending, for the Tropics Zone temperature is from -0.72° Celsius to +1.26° Celsius with respect to a 30 year average base value and the range for the CO_2 annual increment is -1.57 to 1.90 ppm per annum.

Calculation of the Ordinary Linear Regression between the two time series gave a correlation coefficient of 0.65 from the 508 monthly data pairs. Detrending of the time series in order to determine the statistical significance gave a correlation coefficient of 0.54. However the Durbin-Watson test of the time series gave a value of 0.86 indicating positive autocorrelation which means that Ordinary Linear Regression is inapplicable. The autocorrelation was estimated to be 0.57. When applied to transform both time series, that is, applying a First Order Autoregressive Model, it resulted in a correlation coefficient of 0.26 with a minuscule probability of the order of 10^-9 that the coefficient could be zero from the Spearman Rank test.

It follows that this synthesis of empirical data conclusively reveals that CO_2 has not caused temperature change over the past 42 years but that the rate of change in CO_2 concentration has been influenced to a statistically significant degree by the temperature level. Note that it is not likely for a rise in CO_2 concentration to cause the temperature to increase and for the temperature level to control the rate of change of CO_2 concentration as this would mean that there was a positive feedback loop causing both CO_2 concentration and temperature to rise continuously and the oceans could have evaporated long ago.

Support for this thesis is seen in a statistical analysis of the annual rate of change of the monthly CO_2 concentration with respect to the 13 month average lower troposphere temperature for Macquarie Island in the Southern Ocean and for Mt Waliguan, Tibetan Plateau, China.

Chronological Sequence

The above conclusions are supported by the sequence of events recorded at Mauna Loa Observatory for the major 1997 -‘98 El Nino event displayed in Figure 4 below.

The graph displays the time relationship between atmospheric CO_2 concentration at the Mauna Loa Observatory, Hawaii, from the Scripps Institution, compared to the satellite lower troposphere Tropics-Land temperature provide by the University of Alabama, Huntsville, for the major 1997-‘98 El Nino event.

The maximum in the annual increment of the temperature, at October 1997, preceded the maximum in the annual increment in the CO_2 concentration, at March 1998, by 5 months revealing that the CO_2 change could not possibly have caused the temperature change. The maximum in the annual increment in the CO_2 concentration occurred as the temperature reached its maximum, confirming the conclusion in the previous section.

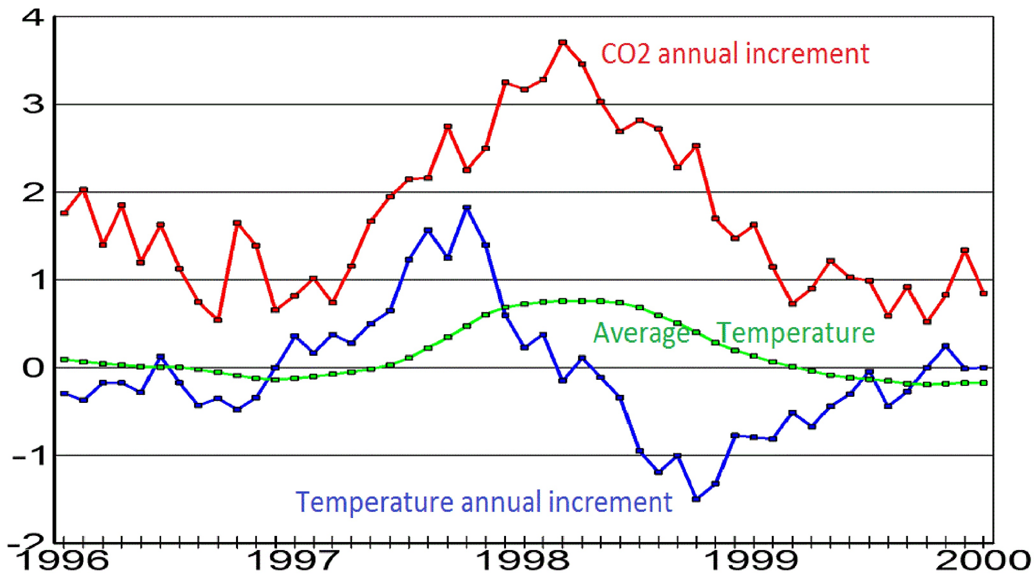

Figure 4: CO_2 annual increment relative to temperature average and annual increment.

Cumulative temperature vs. CO2 concentration

If the temperature determines the rate of generation of CO_2, that is, d/dt CO_2 equals a constant multiplied by the temperature level then, mathematically, this implies that the CO_2 concentration at a given time is proportional to the integral of the temperature up to that time relative to a base value at which no CO_2 is generated. This would be the temperature at which there is a balance between the various sources and sinks of CO_2 at the Earth's surface.

Figure 5 shows the sum with respect to time of the global temperature values relative to a base of -0.99, the minimum value from the global list as a calibrated base is not known, with the range minimum to maximum adjusted to match that of the seasonally adjusted CO_2 range. The resulting near linear trend in the cumulative satellite temperature closely matches that for the seasonally adjusted CO_2 trend as expected under the hypothesis that the temperature drives the rate of generation of CO_2.

Applying the Spearman Rank test, as the distributions are not Normal Distributions, gave a Spearman Rank statistic of 0.999895 with a probability that was too small to be represented by a machine number for the correlation between the seasonally adjusted CO_2 concentration and the cumulative temperature to be zero.

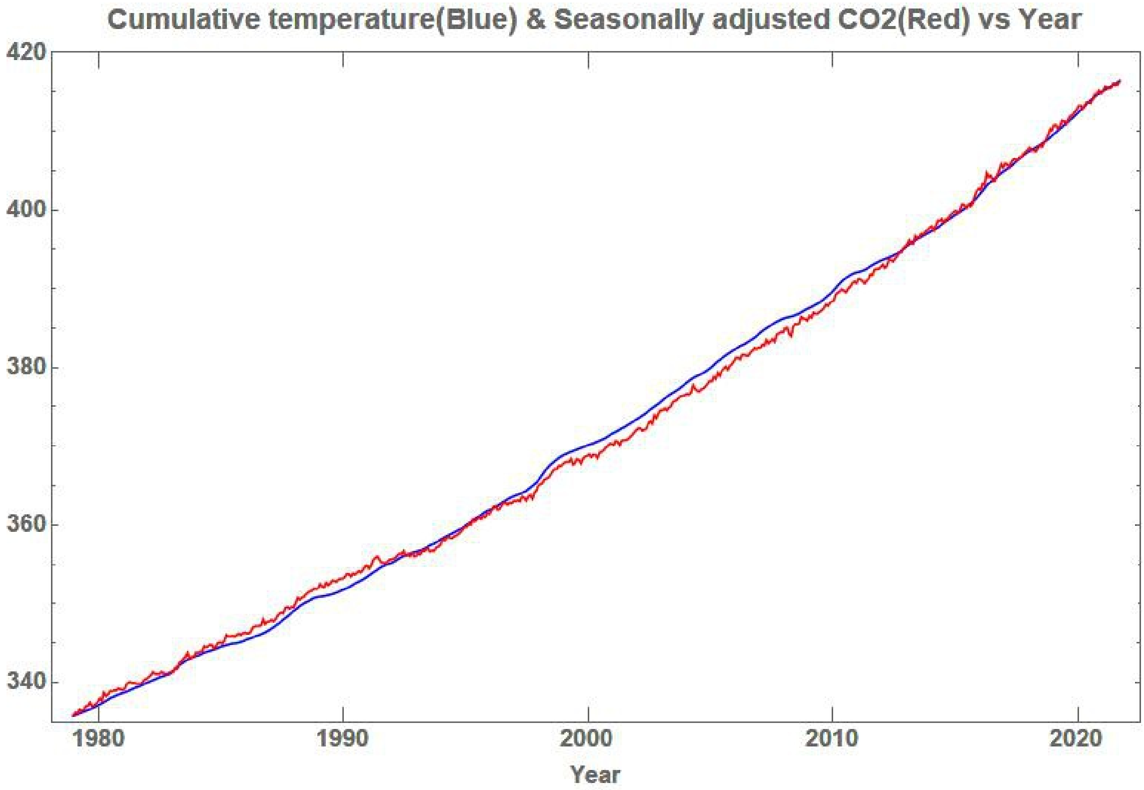

Figure 5. Monthly cumulative satellite temperature and seasonally adjuste**d** CO_2 concentration

The conclusion that the temperature controls the rate of change of CO_2 concentration explains the well known fact that CO_2 change lags temperature change over a large time range. Ice core data has revealed that the cycle of ice ages and inter-glacial warm periods show CO_2 change lagging temperature change by several centuries to more than a millennium while modern CO_2 and global data shows lags of 9.5 to 10 months for atmospheric temperature and 11 to 12 months for sea surface temperature, Humlum et el., 2013 [Ref.5]. Cross correlation of the CO_2 concentration at Mauna Loa and satellite lower tropospheric Tropics Land and Ocean temperatures showed that CO_2 change lagged the temperature change by 9 or 10 months. If temperature controls the rate of change of CO_2 concentration, local maxima in the CO_2 rate must correspond to temperature maxima which, mathematically, must occur after the maxima in the rate of change of temperature. Likewise the CO_2 concentration maxima must post-date the maxima in the CO_2 rate and thus post-date the corresponding temperature maxima.

Put simply, CO_2 has not caused global warming.

Periodic cycles

Additional analysis of the Mauna Loa data gave the following autocorrelation function, Figure 6, for both the annual rate of change of the CO_2 concentration (red line) and the satellite lower troposphere Tropics monthly temperature (blue line). Both data sets covered the period from December 1978 to September 2021. The fact that neither autocorrelation function decreases with increasing lag shows that neither time series is stationary in the statistical sense and dictates that the First Order Autocorrelation Model be applied as was done in calculating the above results.

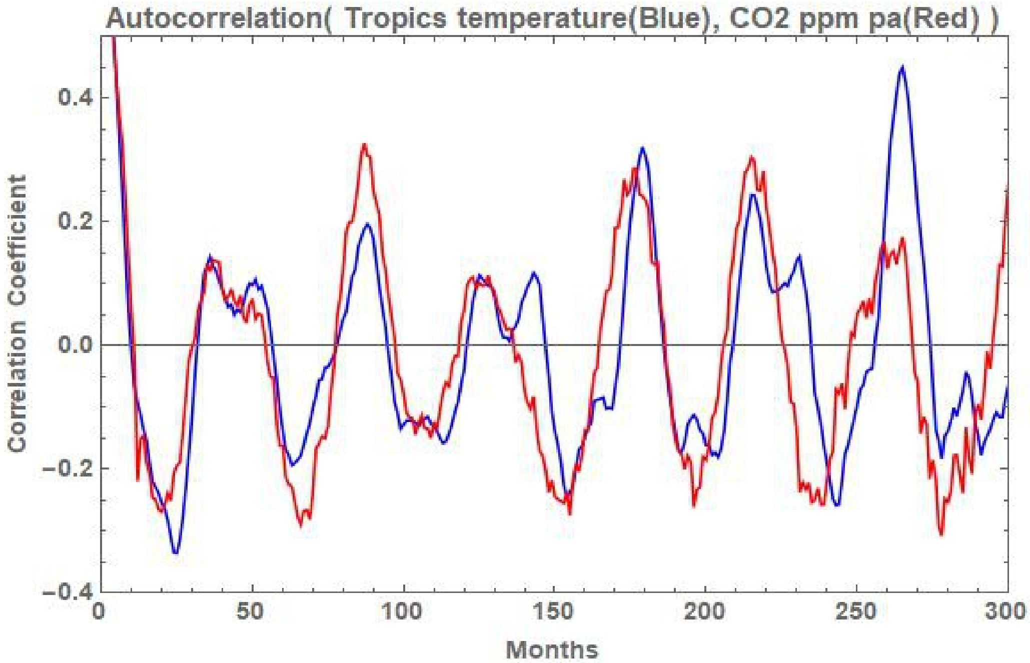

Figure 6: Autocorrelation functions for Mauna Loa rate of change of CO_2 concentration and Tropics Land satellite temperature.

The autocorrelation series are basically identical except that the temperature displays double peaks for the first, third and fifth maxima that are not repeated in the CO_2 rate. This may be due to the fact that the temperature data is an average over the whole of the Tropics zone while the CO_2 concentration is only a measure at one point, the Mauna Loa Observatory, within that zone.

Autocorrelation Table

Source: CO2 rate of change				Source: temperature		
amplitude	years	months	days	amplitude	years	months
0.14	3.08	37	1126	0.14	3.00	36
				0.11	4.25	51
0.33	7.25	87	2648	0.20	7.33	88
0.11	10.25	123	3744	0.12	10.42	125
				0.12	11.92	143
0.29	14.67	176	5357	0.32	14.92	179
0.30	17.92	215	6544	0.24	18.00	216
				0.14	19.25	231
0.18	22.08	265	8066	0.45	22.08	265

This shows that the maxima from the CO_2 rate of change autocorrelation may all be attributed to the El Niño Southern Oscillation with the mean period estimated to be 1282 days. The El Niño event was known to the South American Pacific Ocean fishermen at least as far back as 1600 AD so the event cannot possibly be caused by the atmospheric CO_2 generated by the Industrial Revolution and later industrial advances by mankind. Remarkably, the 42 month period was known

by the Babylonians and Israelites 2500 years ago, being mentioned in the Book of Daniel, Chapter 12.11 ".....1290 days ...", in the Old Testament and the Book of Revelation, Chapter 11.2 "....42 months ..." and Chapter 11.3 ".... 1260 days ...", in the New Testament of the Bible.

A matching response can also be seen in the Fourier Transform amplitude spectrum for each of the time series, as shown below:

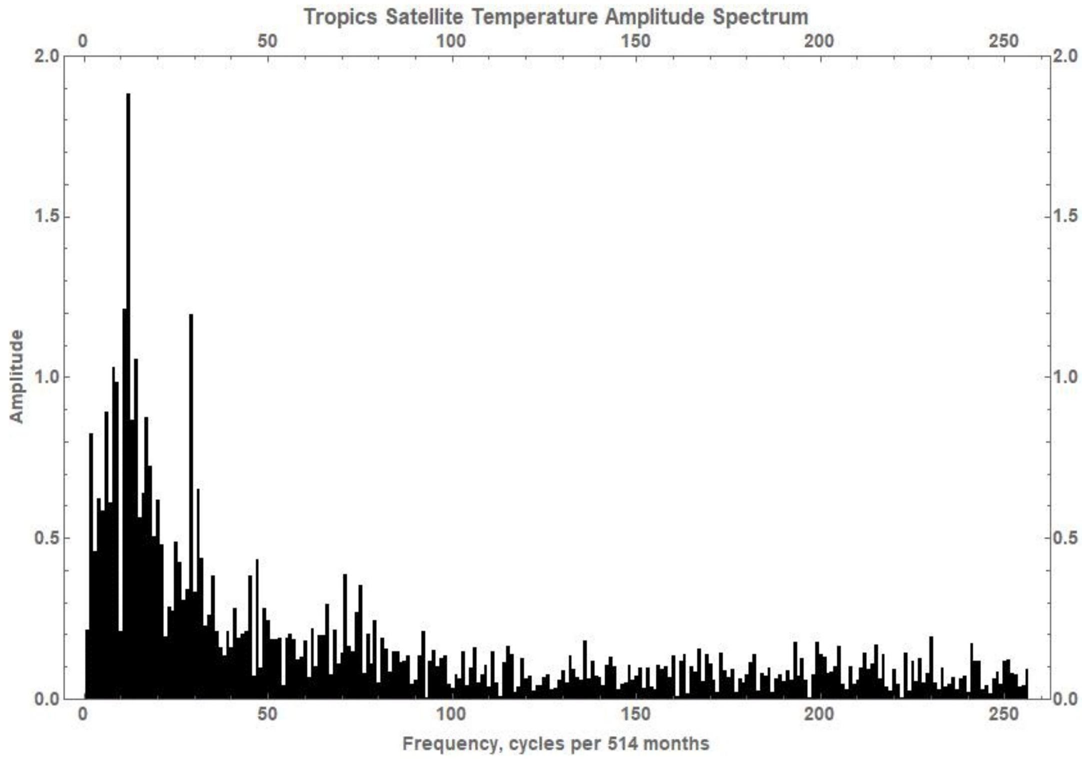

Figure 7: Fourier Transform Amplitude spectrum – Satellite Lower Troposphere Tropics zone.

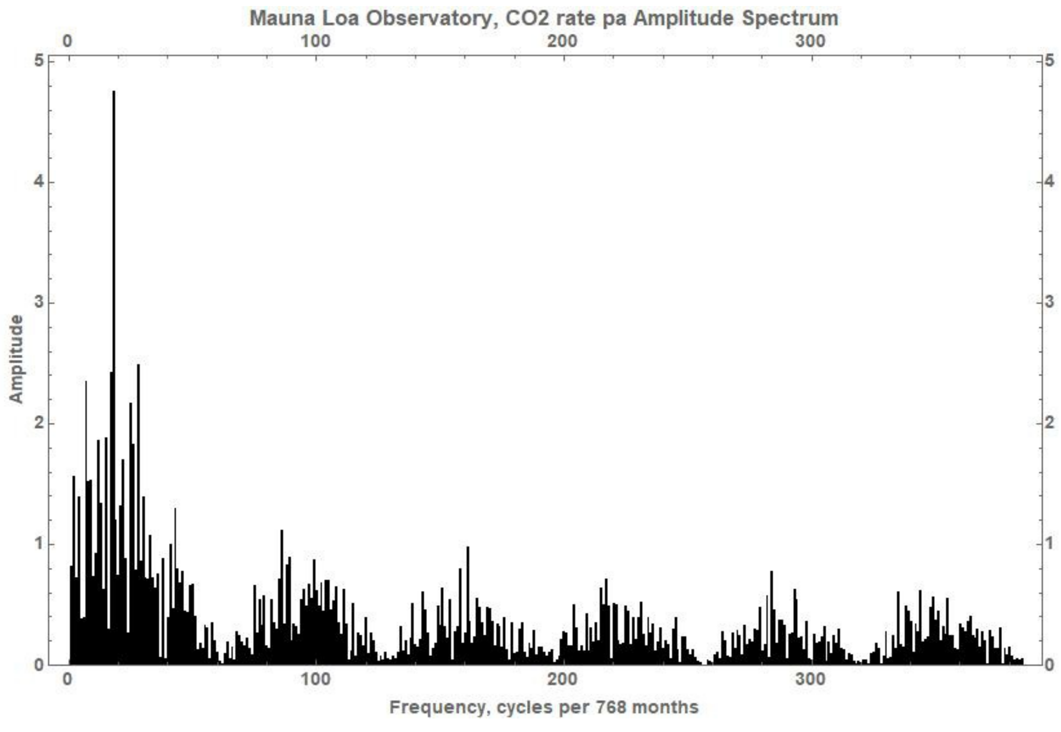

Figure 8: Fourier Transform Amplitude spectrum – Mauna Loa CO_2 annual rate of change

The most prominent maximum on both spectra is at x-coordinate 12 on the satellite lower

troposphere Tropics zone temperature and 17 on the CO_2 rate spectrum, representing a period of 42.7 months resulting from the El Niño Southern Oscillation. It corresponds to the first broad maximum on the earlier correlogram, Figure 6 above. This is in agreement with the paper from Geli Wang et al [Ref. 6] who used wavelet analysis to detect a 3.36 year cycle in the Central England Temperature dataset, which they attributed to the El Niño Southern Oscillation.

Maxima from the amplitude spectrum for the CO_2 rate of change to which a cause may be attributed are:-

x coord	Amplitude	Years	Months	Days	Possible source
2	1.57	32.00	384.0	11688.2	
7	2.35	9.14	109.7	3339.5	Jupiter-Mercury-Moon draconic
18	4.76	3.56	42.7	1298.7	El Niño
25	2.18	2.56	30.7	935.1	8 x Mercury, 34 x Moon draconic
43	1.30	1.49	17.9	543.6	20 x Moon draconic, Venus synodic
86	1.12	0.74	8.9	271.8	9 x Moon synodic,10 x Moon draconic
99	0.88	0.65	7.8	236.1	2 x Mercury, 8 x Moon synodic
143	0.61	0.45	5.4	163.5	6 x Moon draconic
151	0.64	0.42	5.1	154.8	
204	0.51	0.31	3.8	114.6	Mercury, 4 x Moon draconic
245	0.40	0.26	3.1	95.4	3.5 x Moon draconic
284	0.78	0.23	2.7	82.3	3 x Moon draconic
293	0.64	0.22	2.6	79.8	
344	0.62	0.19	2.2	68.0	2.5 x Moon draconic 68.2 days

Accurate predictions as to the period and source of the local maxima in the amplitude spectra are not feasible due to the course sample interval of one month and the short time series of only 514 months for the temperature and 751 months for the CO_2 annual rate of change. The identity of the possible causes of the maxima were taken from the values for the synodic periods of the planets and the synodic and draconic periods of the Moon with no attempt having been made to take into account the periodic changes in ellipticity or tilt angle of the elliptic planes relative to that of the Earth

This has been partly resolved by using the weekly Mauna Loa atmospheric CO_2 concentration time series as proxy for the atmospheric temperature as shown on the accompanying web page "Mauna Loa Weekly Data". It is notable that both the synodic and draconic periods of the Moon are apparent in the weekly series. An explanation for the synodic period is that each New Moon reduces the incoming Sun's radiation to the Earth and its atmosphere as it passes between the Sun and the Earth. The draconic period is due to the Moon's elliptical plane being at an angle of 5.14° to the Earth's elliptic relative to the Sun. As a result, when the Moon passes through one of the two nodal points, where the Moon's ellipse intersects the Earth's elliptic, it has the greatest influence in diminishing the irradiation of the Earth which, in turn, reduces the Earth's surface temperature thereby causing a response in the rate of generation of CO_2

Evidence that the 42 month cycle is due to the El Niño event is seen in the responses over the South Pole as shown below. Once again the time series are of different lengths with the annual rate of change of the CO_2 concentration (red line) covering the period June 1957 to December 2016 and the satellite lower troposphere South Pole Land monthly temperature (blue line) covering the period December 1978 to October 2017.

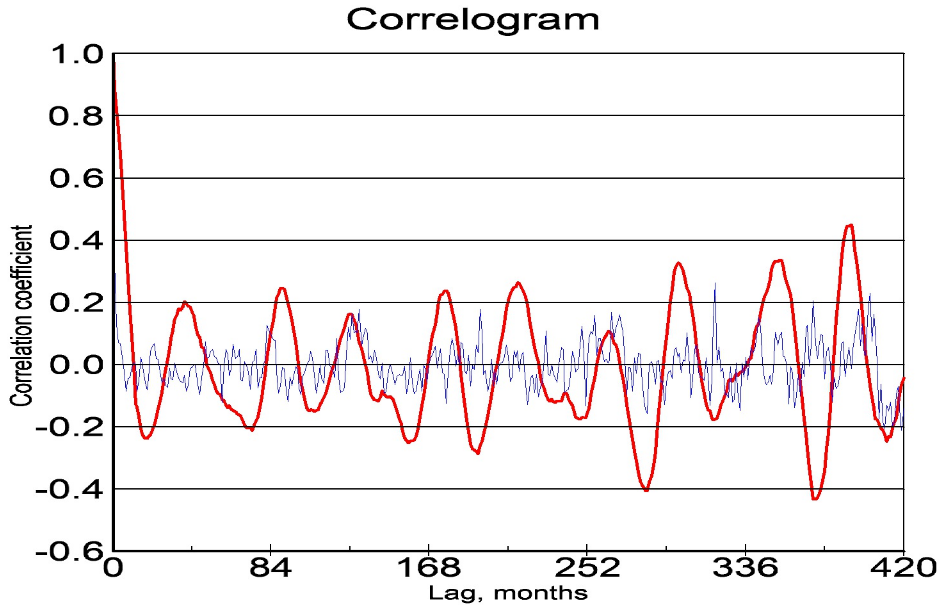

Figure 8: Autocorrelation functions for South Pole rate of change of CO_2 concentration and South Pole Land satellite temperature.

There is an obvious difference between the time series. The periodic nature of the annual rate of change of the CO_2 concentration repeats the wavelength of that from Mauna Loa while it is barely discernable for the South Pole satellite lower troposphere temperature series. The DFT amplitude spectra confirm the difference as seen here:

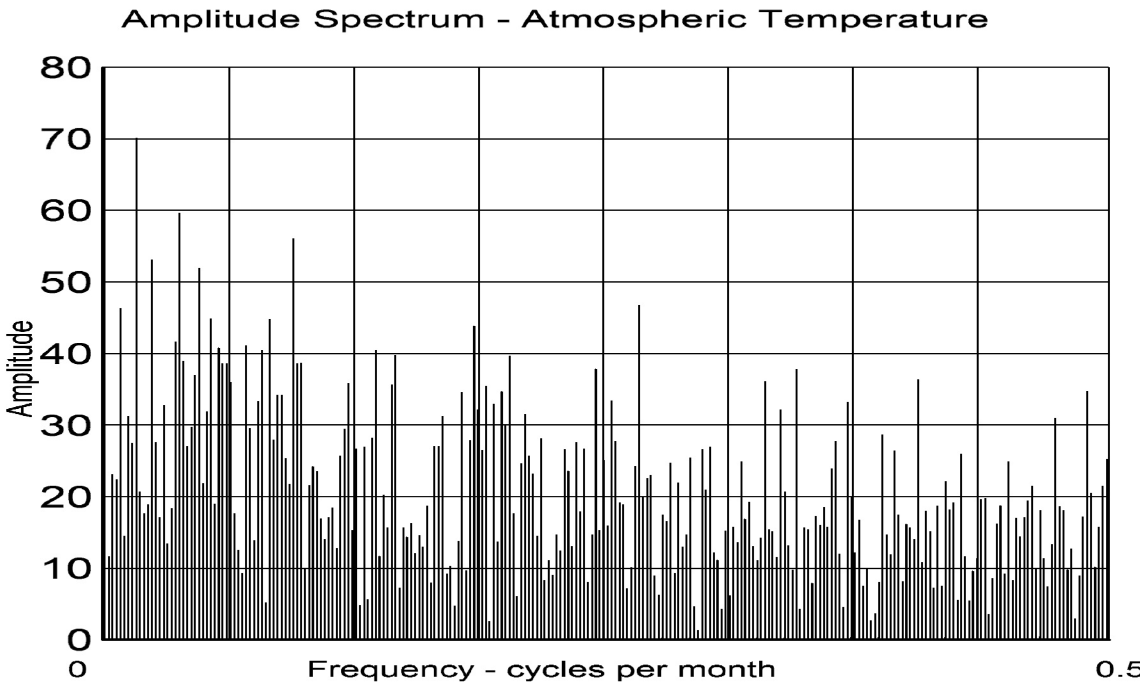

Figure 9: Fourier Transform Amplitude spectrum – Satellite Lower Troposphere South Pole Land

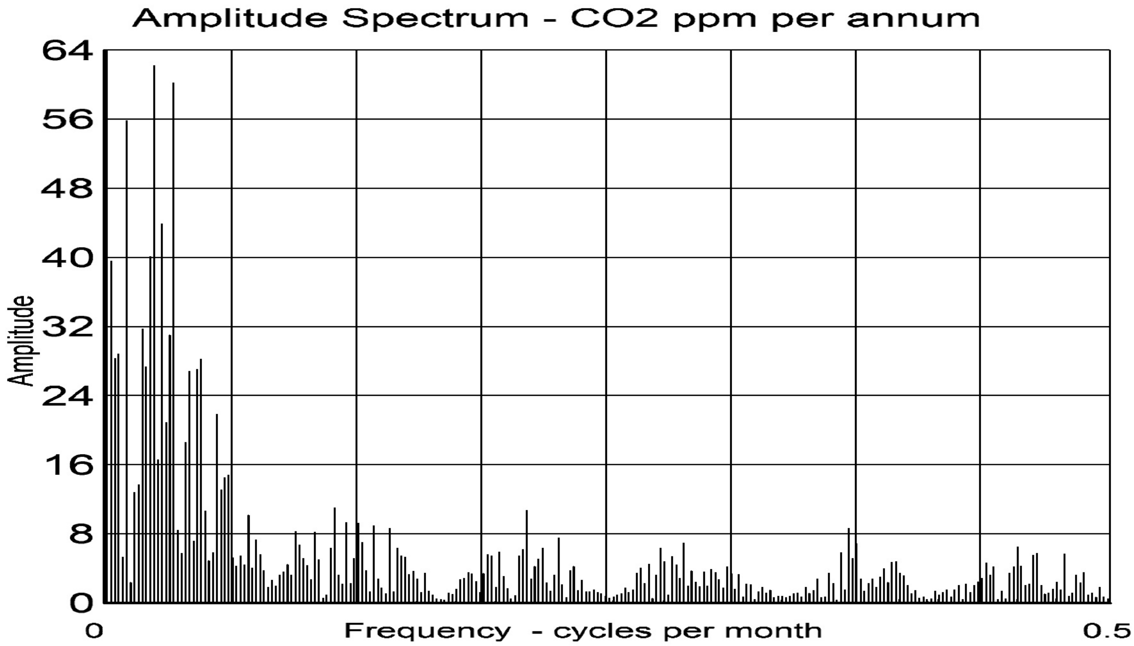

Figure 10: Fourier Transform Amplitude Spectrum –South Pole CO2 annual rate of change

The peak in the amplitude spectrum for the annual rate of change of CO_2 concentration remains at the wavelength of 42.7 months. However the power spectra for the satellite lower troposphere temperature has the 42.7 month peak in fourth spot with greater amplitude peaks occurring at wavelengths (in decreasing amplitude) of 64 months (which may be the synodic period for the Moon and Mercury and/or Jupiter), 26.9 months (which may be the synodic period for Mars and/or Jupiter) and 10.7 months (which represents 11 synodic cycles of the Moon). The reduction in the 42.7 month peak is reasonable considering the fact that the Sun's rays are practically tangential to the polar surface or do not impinge on part of that surface for months at a time due to the Moon's orbit being inclined at 5° to the elliptic.

The CO_2 concentration over the South Polar region has been, on average, 2.2 ppm less than over the Tropics for the 58 years of recording during which time the concentration at the South Pole increased by 86.8 ppm and at Mauna Loa the increase was 88.3 ppm with the difference being statistically significant at the 99% level.

The clear similarity between the autocorrelation function and the power spectra for the two time series, temperature and rate of change of CO_2 concentration, from the Equatorial zone support the original contention that the temperature drives the rate of change of CO_2 concentration. As the Tropics has the highest average temperature it must produce CO_2 at the greatest rate. That CO_2 must diffuse North and South away from the Equator into the Polar regions. As the solubility of CO_2 increases with decreasing temperature it must be precipitated at the Poles within the hail and snow. That is, there may be a continuous circulation of carbon from the Equatorial Zone, through the atmosphere as CO_2, to the Poles where it is locked into the Polar ice sheets until those sheets move sufficiently far from the Pole to melt. The CO_2 is then concentrated in sea water and may return towards the Equatorial zone via the Earth's oceans.

That is, the Tropics is a source for the atmospheric CO_2 and the Polar regions are a sink. As the seasonal variation from photosynthesis can be as great as 20 ppm in amplitude, it is possible that the almost 1.6 ppm per annum increase in CO_2 concentration over the past 64 years has arisen from biogenetic sources driven by the natural rise in temperature following the last ice age. The

Tropics has the greatest profusion of life forms throughout the Globe, so this may be a feasible source for the increase in CO_2 concentration for that period. That could include an increase in the population of soil microbes thereby increasing the fertility of the soil leading to the greening of the Earth as can now be seen in satellite imagery. This is supported by an extensive study of global soil carbon which, quote: "provides strong empirical support for the idea that rising temperatures will stimulate the net loss of soil carbon to the atmosphere" end quote, Crowther et el 2016 [Ref.7].

This result suggests that perturbations in the Sun's irradiance, under the influence of the gravitational effect of the planetary orbits largely control the temperature variation of the Earth which, in turn, controls the rate of change of the CO_2 concentration in the atmosphere.

Conclusion

There is no statistical evidence for the claim by the UN IPCC that a rise in CO_2 concentration causes a rise in the temperature of the lower troposphere but there is highly significant evidence that the temperature determines the rate of change of CO_2 concentration. Added to that is a secondary conclusion that there is a prominent 42 month cycle for the temperature due to a repeated occurrence of a configuration of the Solar system which is expressed in the Earth's climate as the El Niño event. It also causes the same cycle in the rate of change of CO_2 concentration. Furthermore other cycles in the temperature and the CO_2 rate spectra may relate to orbital cycles of the planets indicating that, at least in terms of months and years, the orientation of the planets with respect to the Sun determine changes in the Earth's temperature which result in coincident changes in the rate of change of CO_2. That is, an important factor in the Earth's climate change arises from the continually changing position of the Moon and the planets relative to the Earth and the Sun and has nothing whatsoever to do with the concentration of CO_2 in the atmosphere as this is a consequence of the climate change.

References:

[1] The satellite lower troposphere temperature data is freely available from the University of Alabama, Huntsville, on Dr Roy Spencer's Web site at:
http://www.nsstc.uah.edu/data/msu/v6.0/tlt/uahncdc_lt_6.0.txt

[2] The CO2 concentration data for the Mauna Loa Observatory is freely available from the Scripps Institute via the Web page:
https://scrippsco2.ucsd.edu/data/atmospheric_co2/mlo.html
Files: monthly_in_situ_co2_mlo.csv and weekly_in_situ_co2_mlo.csv

[5] Ole Humlum, Kjell Stordahl, Jan-Erik Solheim, "The phase relation between atmospheric carbon dioxide and global temperature", Global and Planetary Change 100 (2013) 51-69.

[6] Identification of the driving forces of climate change using the longest instrumental temperature record. Geli Wang, Peicai Yang & Xiuji Zhou
Scientific Reports 7, Article number: 46091 (2017), doi:10.1038/srep46091

[7] T.W. Crowther, et el, "Quatifying global soil carbon losses in response to warming" Nature, Vol. 540, 104-108, 01 December 2016, Letter